ABSTRACT

In Power Systems, distribution transformers are found in large numbers at the consumer end. The design and manufacturing or marketing of distribution transformers thus become a competitive one. It can be overcome only at the time of design. The transformers are generally to satisfy one of the objectives, viz. cost, weight, volume or losses depending upon the need of the consumer and their circumstances to be minimum or optimum. The transformer may be said accordingly as optimum cost, weight, volume or loss transformer. The above objectives are governed by many variables. It is the general practice that some variables are assumed as known and fixed and other variables are treated as independent or free variables. The optimization is finding optimum values for these independent variables and making the objective optimum or minimum. The conventional design is a trial and error method and analytical one. Empirical equations and assumption of values for the variables are made use of in the conventional design. Hence it is difficult to arrive at an optimum design. At the same time, in computer based optimizing method, the steps involved are (i) synthesis (ii) analysis and (iii) an optimizing routine. In this method the optimum value of a variable, which appear in design equation, is achieved, which in turn is used to minimize or maximize a quantity of interest in the calculation subsequently.
The transformer is made up of basically iron and copper. The objectives indicated above are directly related to iron and copper. For example, for optimum cost design, the total cost is to be minimum. The total cost is nothing but the sum of cost of iron and cost of copper only. However for the total cost to be minimum, the condition, namely, the cost of iron must equal to the cost of copper is to be satisfied for obtaining rated power output. Hence the objective function for total cost is written as a sum of the cost of iron and cost of copper, where, the cost of iron and cost of copper themselves are treated as variables and making the objective function as a sum of two variables.

The transformer is supposed to deliver its rated kVA as output and so the output of the transformer itself is taken as constraint. It is therefore necessary that the output equation is to be modified substituting the known values for the variables in the equation and finally obtaining an equation in terms of two variables as they appear in the objective function.

Thus the objective function and constraint equation are formed only with the help of two variables depending upon the objective in mind, where the requirements for any optimizing problem are fulfilled.

Since the number of variables which are required to be the optimum is only two in number, graphical method is suggested and the values for the variables are obtained. It is an analytical method. The
special feature of this method is that the values for the variables are obtained simultaneously and quickly. Moreover, the values are unique. The results obtained are verified with the available, namely, Lagrangian multiplier method and Random jumping method. A distribution transformer design problem, one in single phase and the other in three phase is taken and the methodology is adopted and the results obtained are compared. A good agreement is found. The result of a three phase transformer which is of practical interest is also compared with the available test certificate of a company where they normally give only performance data (not the design data) and found satisfactory.

It is stated that for a distribution transformer, the voltage regulation is the main performance requirement. The Indian Electricity Rules, 1956 states that the voltage regulation must not be more than 6% for medium and low voltages. Voltage regulation is calculated from the results obtained by the proposed method and presented.

A new algorithm for overall optimum design of a distribution transformer is presented using two variable approach.